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Multiresource Inventories: Techniques for Evaluating Nongame Bird Habitat

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ABSTRACT.—Procedures for evaluating the suitability of forest lands for the breeding habitat of individual nongame bird species and entire avian communities are presented. A multiresource inventory of South Carolina's forest resources, conducted by Renewable Resources Evaluation (formerly Forest Survey), provides the necessary habitat data. Nine nongame bird species, representative of a broad range of habitat types, are selected as examples for evaluation. Habitat descriptions for these species were obtained from the literature and the screening criteria were formulated. The resulting estimates of habitat extent, condition, and distribution are presented.

Keywords: Wildlife habitat evaluation, habitat parameters, multiple use.

The management of forests for nongame bird species has gained considerable support in recent years. Our increasingly urbanized and environment-aware society views the intangible benefits attributed to nongame birds as being as important as the more tangible benefits attributed to game animals.

Esthetic values are not the only benefits derived from maintaining large, diverse bird populations in forest lands. DeGraaf and Payne (1975) estimated the economic value of expenditures in the United States directly attributed to the enjoyment of nongame birds in 1974 to be about $500 million. The ecological role of birds in forest ecosystems is not yet fully understood, but many studies indicate that birds may play some role in controlling insect populations (Bruns 1960; Buckner 1966; Buckner and Turnock 1965; Franz 1961; Koplin 1972; Morris and others 1958; Solomon and Morris 1970; Telford and Herman 1963; Tinbergen 1960). Another possible role is that of a monitor of environmental integrity of our forests (Plunkett 1979).

The USDA Forest Service, with other wildlife and conservation organizations, sponsored a 1975 symposium (Smith 1975) and several subsequent workshops (DeGraaf 1978a, 1978b; USDA FS 1979) on the management of our Nation's forest lands for nongame birds. The growing need for coordinated management of nongame bird habitat with timber management was addressed at these meetings. In discussing information needs for managing forest and range habitats for nongame birds at the 1975 symposium, Lennartz and Bjugstad (1975) stated that the most basic information needed was a characterization of the extent, distribution, and condition of the resource base. Such information has not been available in the United States. They suggested that avian habitat assessments be incorporated into existing regional forest inventories.

In this Paper, I demonstrate how multiresource inventory data (McClure and others 1979) collected in South Carolina may be used to estimate the suitability of large forested areas (states or portions thereof) for selected nongame bird breeding habitat. Nine nongame bird species, representing a broad range of habitat groups, are selected as examples. I present the habitat evaluation criteria for each species and resulting estimates of the extent, condition, and distribution of habitat for each.

HABITAT DATA

The data needed to evaluate the breeding habitat of the selected nongame birds were collected by U.S. Forest Service Renewable Resources Evaluation (RRE) field crews throughout South Carolina during 1977 and 1978. The South Carolina multiresource inventory is part of a nationwide pilot effort to evaluate all forest-related renewable resources. These inventories are authorized by the Forest and Rangeland Renewable Resources Research Act of 1978. More detailed information on the history and purpose of the inventories is available in a paper by McClure and others (1979).

The data were collected at 4,034 permanent sample plots established on commercial forest land throughout the State. The commercial forest acre-

age in South Carolina totals 12.5 million acres, representing a broad range of forest conditions (Sheffield 1979). The State contains a small portion of the Southern Appalachian Mountains, a large area of rolling Piedmont laced with narrow flood plains, an extensive belt of sandhills, and a broad expanse of flat coastal plain interspersed with swamps and broad flood plains. For inventory purposes, the State is divided into three Survey Units: (1) Southern Coastal Plain, (2) Northern Coastal Plain, and (3) Piedmont (fig. 1). The small mountainous area is in the Piedmont, and the sandhills in both Coastal Plain Units.

The randomly selected and systematically spaced permanent plots were previously used exclusively for collection of timber data. Little is known about the sampling procedures, levels of precision, or number of samples needed for multiresource inventories. The sampling procedures for timber, however, are designed to provide reliable estimates of area, inventory volume, growth, and removals at the Survey Unit and State levels. This study of nongame bird habitat evaluation is for the entire State in order to minimize sampling errors.

Much of the typical timber-related data collected for the past several years on RRE sample plots are useful for evaluating wildlife habitat. For instance, stand age, forest type, physiographic class, stand size, the presence of cull trees, timber volume, and tree stocking can be related to the presence or absence of breeding birds. Habitat selection by breeding birds is related to such conspicuous features of the habitat (James 1971; Lack 1933). Lennartz and McClure (1979) used six of these typical timber-related items to screen all RRE plots in the Southeast and estimate the area of potential red-cockaded woodpecker *(Picoides borealis)* nesting habitat. They found definite correlations between their estimates of potential habitat and reported population concentrations for the woodpecker.

More specialized data were collected for the evaluation of wildlife habitat; many of these items were used to evaluate habitat for the nine species. These items include the presence of natural and artificial cover factors (rock outcrops, holes, logging slash, etc.), tree cavities, snags, the occurrence of water, type of water, proximity of nonforest land uses, and percentage of forest cover. The

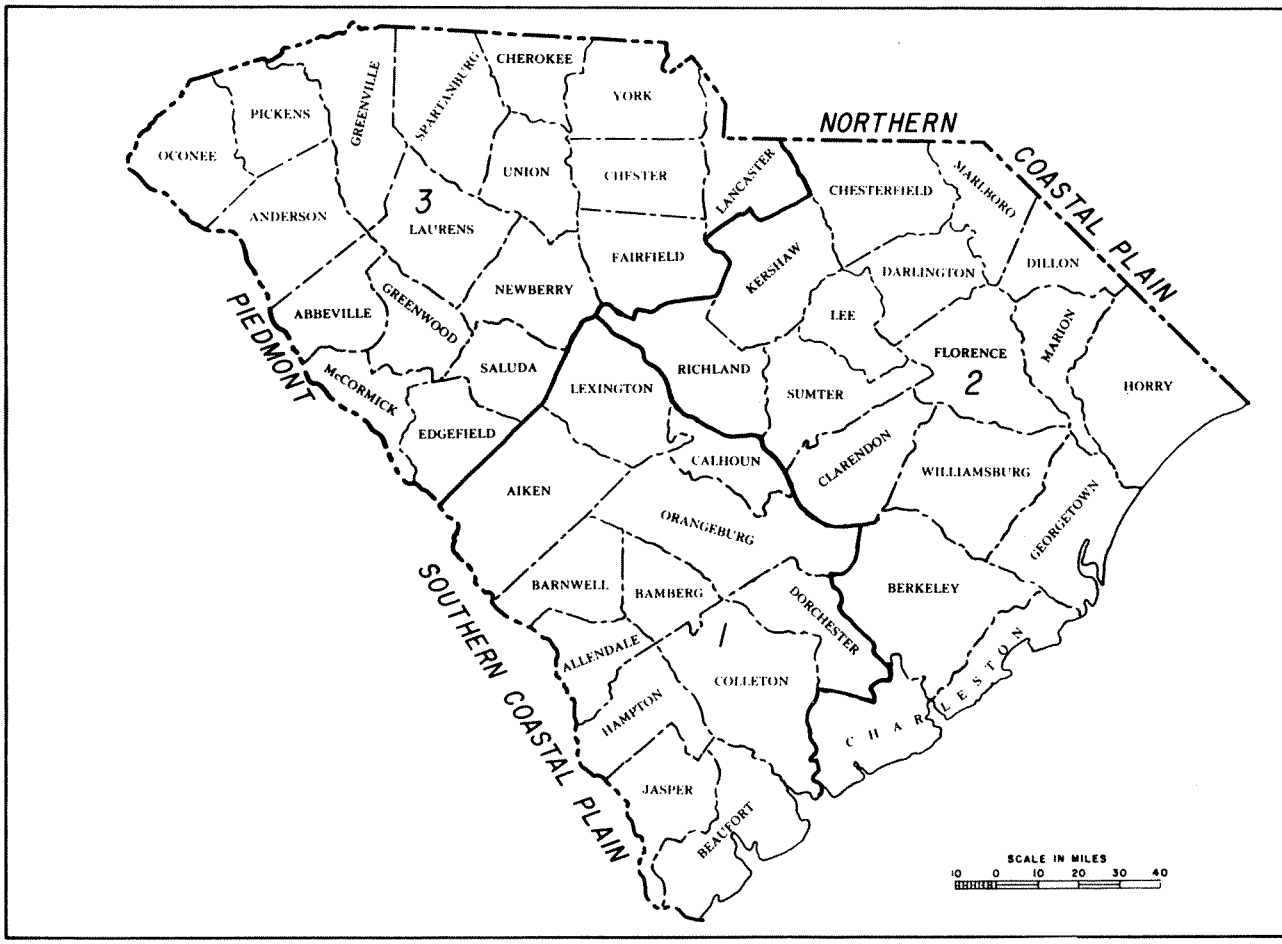

Figure 1.—Forest Survey Units in South Carolina.

tree cavity and snag data were found to be incomplete for cutover forest land and were not used as evaluation criteria; the presence of decayed cull trees was used as a substitute in some cases. This data-collection problem has been remedied in subsequent inventories.

A vegetative profile study (Cost 1979; McClure and others 1979) was incorporated into the inventory process to provide data on the lesser vegetation. When pooled with the tree tally information, these data provide a picture of the horizontal and vertical vegetative structure of the forest. This information is best depicted graphically in a profile. Figure 2 shows such a profile for a typical 20- to 39-year-old oak-hickory stand. The percentage of the total space which is occupied with vegetation within each 1-foot height zone is displayed and is referred to as "vegetative stocking" in the habitat evaluation criteria for individual bird species. To facilitate describing habitats, several vertical vegetative layers are defined. These zones are the ground layer (0 to 1 foot), shrub layer (1 to 5 feet), understory layer (5 to 15 feet), midstory layer (15 to 30 feet), and the overstory layer (30 to 80 feet). The stocking within any other defined vertical stratum may also be computed and used to evaluate habitat.

SPECIES HABITAT GROUPS AND SPECIES SELECTION

Habitat groups (or types) were selected and described to represent a range of habitats from the early to the late successional stages and with ground-to-canopy vertical foliage strata. Thus, forest habitat for bird species characteristic of early successional old fields and clearcuts, climax hardwood stands, and all vertical strata can be evaluated. A specialized bird species group was included to represent the habitat requirements of cavity-nesting bird species. Cavity nesters have been found to be an important component of the total avian community (Haapanen 1965). Other specialized bird groups such as the raptors could be included in similar specialized groups. The specialized bird group is also subdivided to represent a range of successional stages and vertical strata.

The habitat groups were used to provide a framework for evaluating entire avian communities. These groups do not necessarily represent natural groupings. A species which was selected as a representative of a particular habitat group may also be found in forest conditions characteristic of another group. The habitat groups ensure selection of species representative of a wide range of forest conditions.

The species selected for evaluation (table 1) from each habitat group is chosen merely as a member of that group and is not necessarily representative of the entire group. However, the chosen species may well be an indicator species for that group. Anderson (1979) suggests using this indicator species approach to management for avian communities. Each habitat group could be more fully evaluated by selecting several representative species for each group. Only one species is used to represent each habitat group in this Paper because the demonstration of the techniques and process of habitat evaluation for the entire range of habitat groups (and, consequently, avian communities) is more consistent with the objectives than is a complete evaluation of only one group.

The species for each habitat group were selected because, in general, they are somewhat limited in their distribution in time (successional stage) and space (vertical strata). These stenotopic species have limited adaptability to habitat variability and requirement for a specific habitat component(s) to complete some phase of their life cycle. Thus, these species provide the greatest challenge and potential for management. Wide-ranging, adaptable species—eurytopic—present little need for management because they thrive equally well in almost any habitat. This trait also makes habitat evaluation difficult. For these reasons eurytopic species were not deemed suitable for analysis by the presented methods. All selected species breed in South Carolina and other parts of the Southeast.

Ground and Shrub Habitats

The ground and shrub habitat group is characterized by the presence of a well-developed shrub stratum. In general, birds found in ground and shrub habitats nest in shrubs and low saplings or on the ground. The low vegetation also provides food and cover. The ground and shrub habitat group is divided into two subgroups based on successional age.

Early successional.—These habitats generally include the early successional old fields and areas of recent heavy timber cutting. The absence of a well-developed canopy stratum best describes these habitats. Successional age of these habitats may vary considerably, depending on the level of stocking in a particular area. For instance, an old field supporting a dense stocking of pine may form a closed canopy between 10 and 20 years. But the same old field with only scattered trees may qualify as early successional shrub habitat for 20 to 30 years or more. The prairie warbler is selected for habitat evaluation for this habitat group.

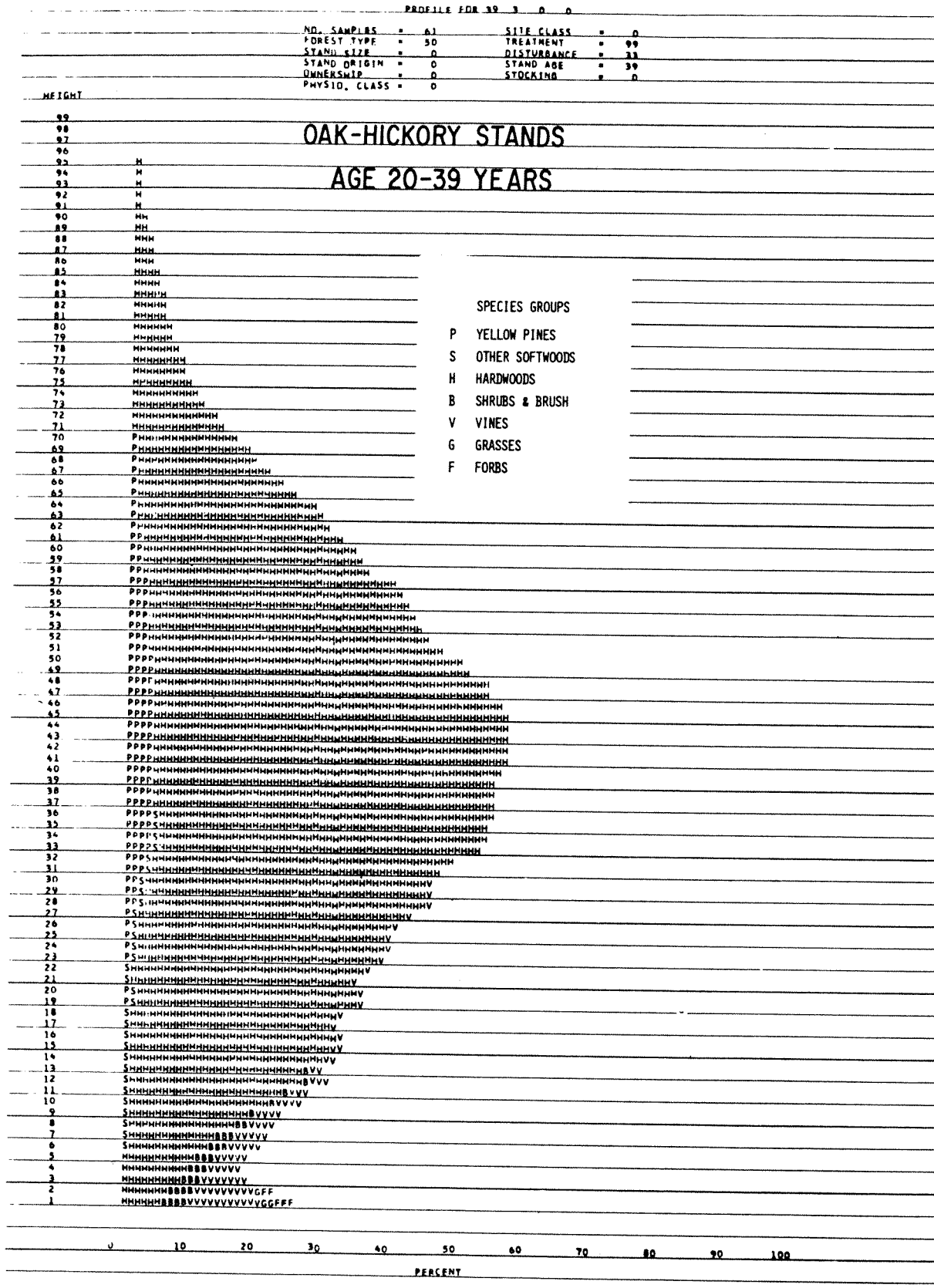

Figure 2.—Horizontal and vertical structure of broad classes of plants for oak-hickory stands, 20 to 39 years, Piedmont, South Carolina, 1977.

Table 1.—Selected nongame bird species with symbols used in tables 3, 4, and 5

Species	Symbol	Scientific name
Brown-headed nuthatch	BRNU	*Sitta pusilla*
Downy woodpecker	DOWO	*Dendrocopus pubescens*
Eastern bluebird	EABL	*Sialia sialis*
Pileated woodpecker	PIWO	*Dendrocopus pileatus*
Pine warbler	PINW	*Dendroica pinus*
Prairie warbler	PRWA	*Dendroica discolor*
Prothonotary warbler	PROW	*Protonotaria citrea*
Red-eyed vireo	REVI	*Vireo olivaceus*
Wood thrush	WOTH	*Hylocichla mustelina*

Late successional.—Late successional ground and shrub habitats are characterized by the presence of a shrub stratum beneath a well-developed canopy. This condition is most often found in mature hardwood stands, but may exist in older pine and the transitional oak-pine stands. The wood thrush is selected for evaluation from this group.

Canopy Habitats

A well-developed overstory layer in forests provides the canopy habitat. Shrub, understory, and midstory strata may be present but are not a necessary requirement for all canopy-dwelling bird species. Some species may require other strata for nesting, but the overstory stratum is the primary requirement. This habitat group is divided into two subgroups based on successional age.

Pine forests.—Forests in which pine species *(Pinus* spp.*)* make up a substantial portion of the overstory stratum are home to several bird species. Some of these birds occur at their greatest density in pure pine stands and decrease in numbers with the invasion of hardwood species. The pine warbler is typical of such population trends and is selected for habitat evaluation.

Hardwood forests.—Hardwood canopy habitats consist of a well-developed overstory stratum made up mostly of hardwood species. Birds belonging to this group generally appear with the emergence of hardwood trees into the canopy of pine forests and increase until a mature hardwood stand exists. The red-eyed vireo is a typical representative of this group and is selected for evaluation.

Specialized Bird Habitats

The specialized bird habitat group is separated into primary cavity nesters (species that excavate their own hole) and secondary cavity nesters (species that use natural cavities and woodpecker holes for nesting).

Primary cavity nesters.—This group is represented by two woodpeckers in this Paper—the pileated woodpecker and the downy woodpecker. The pileated woodpecker is characteristic of dense, mature hardwood and pine forests. Less mature, open forests are the most characteristic habitat of the downy woodpecker.

Secondary cavity nesters.—This group is represented by three species, each somewhat characteristic of a particular forest condition. Mature pine stands are represented by the brown-headed nuthatch, bottomland hardwood stands by the prothonotary warbler, and clearcuts and open forests by the eastern bluebird.

TECHNIQUES FOR DETERMINING HABITAT SUITABILITY

A major problem in quantifying the habitats of nongame birds is that most available habitat information is qualitative in nature rather than quantitative (Hooper and Crawford 1969). Some of the more recent research studies (Anderson and Shugart 1974a, 1974b; Conner and Adkisson 1977; James 1971; Shugart and others 1975; Whitmore 1975, 1977) have used quantitative methods to relate the occurrence of bird species to specific habitat variables but, in general, have stopped short of providing precise habitat guidelines for a particular bird species. For instance, what is the optimum tree stocking, species composition, or vegetative coverage within any particular vertical layer for a certain species? At a recent symposium and workshop on nongame birds, this lack of information was identified as a major deterrent to nongame bird management (DeGraaf 1978a; Smith 1975).

In this study, each sample stand is ranked as either unsuitable habitat or as good, acceptable, or poor habitat for each species. To rank these stands or habitats in this manner, quantitative guidelines

had to be established for each habitat parameter determined from the literature to be important to each species' occurrence. Since such guidelines were usually absent from the literature, the importance of each habitat criterion and the dividing lines between the various habitat rankings were determined subjectively. Empirical research results should replace these judgments in the future.

The first step in ranking is to determine which habitat parameters are of major importance to a particular species' occurrence. The dividing line between suitable and unsuitable for each habitat parameter is established, and each sample stand not qualifying as suitable for any of these parameters is given an overall rank of unsuitable (code 0) for that particular species. For example, suppose species X can exist only in forests consisting mainly of pine trees 30 years of age and older with well-developed vegetative layers below the overstory. Sample stands will be ranked as unsuitable habitat for species X unless the stands are composed of mostly pine trees (50 percent or more of the total basal-area tree stocking) with a stand age of 30 years or more, and with 15 percent or greater vegetative stocking in any 1-foot stratum below the overstory, excluding the 0- to 1-foot zone. All stands meeting each of these three requirements for species X habitat are suitable and are further ranked as good (code 3), acceptable (code 2), or poor (code 1) habitat.

Ranking suitable habitats as good, acceptable, or poor is accomplished by considering all habitat parameters of any importance to a species' occurrence. These variables are usually further refinements of ones used in the initial separation of unsuitable and suitable habitats, but other, less crucial, variables may be considered if they contribute to a species' occurrence in a particular habitat. Each habitat variable is subjectively divided into good, acceptable, and poor segments based on the range of values possible for that variable, excluding the unsuitable segments. All identified habitat variables are then assigned numerical values based on whether the variable for the sample stand falls in the good (3 points), acceptable (2 points), or poor (1 point) range. Habitat rank is then determined from the number of points accumulated out of the total possible. For example, the ranking criteria for species X are:

Unsuitable habitats.—Sample stand does not qualify as suitable habitat if any of the following conditions exist:

1. Proportion of live-tree stocking made up of pine species is less than 50 percent.
2. Stand age is less than 30 years.
3. All 1-foot strata in the shrub, understory, and midstory layers are less than 15 percent stocked with vegetation.

Suitable habitats.—Sample stands classified as suitable habitat are ranked according to the total number of points accumulated from consideration of the following items (point values in parentheses).

1. Proportion of live-tree stocking made up of pine species:
   a. 80 percent or more (3)
   b. 65-79 percent (2)
   c. 50-64 percent (1)
2. Stand age:
   a. 70 years or more (3)
   b. 50-69 years (2)
   c. 30-49 years (1)
3. Vegetative stocking in 1-foot stratum of highest density in the shrub, understory, or midstory layers:
   a. 65 percent or more (3)
   b. 40-64 percent (2)
   c. 15-39 percent (1)

Habitat Rank Determination

Habitat rank	*Code*	*Total accumulated points*
Good	3	8-9
Acceptable	2	5-7
Poor	1	3-4
Unsuitable	0	0

Using these criteria, a stand consisting of only pine species 40 years old with a maximum vegetative stocking in any 1-foot stratum in the shrub, understory, or midstory of 25 percent would be assigned a total of 5 points and would qualify as acceptable habitat. For this example and for the following nine species, it is not possible for a plot to be assigned the total point values between 0 and the minimum number of points shown because of the screening logic.

SELECTED SPECIES HABITAT CRITERIA

The criteria for describing and evaluating the habitat of each selected species are taken from the available literature for each bird.

Prairie Warbler

The primary breeding habitats of the prairie warbler are located in the earliest stages of a successional continuum. Intermediate or greater shrub densities are necessary (James 1971). The shrub layer is important since the prairie warbler nests in shrubs and low trees (Bent 1953; Burleigh 1958; Griscom and Sprunt 1957). These early successional habitats may be the result of old-field succession (Johnston and Odum 1956; Parnell 1969; Shugart; and James 1973; Sprunt and Chamberlain 1970) or timber cutting (Ambrose 1975; Bent 1953; Hooper 1967; Noble and Hamilton 1976; Oelke 1966; Parnell 1964). Meyers and Johnson's (1978) analysis of

numerous breeding bird censuses also confirms that prairie warblers occur at highest densities in the youngest stands. Some older forest stands provide suitable habitat, provided the overstory layer is relatively open and a shrub layer is well developed (Burleigh 1958; Noble and Hamilton 1976).

The habitat screening criteria for the prairie warbler were developed from the preceding literature citations. The presence of a well-developed shrub stratum in stands without a closed canopy is an overriding factor in separating suitable habitats from unsuitable ones. Stand age is also important, with the younger stands qualifying as suitable and the older stands as unsuitable unless the canopy is open. The same three factors are used to rank the suitable habitats into good, acceptable, and poor classes. The criteria for evaluating prairie warbler habitat are:

Unsuitable habitats.

1. Vegetative stocking in any 1-foot stratum more than 25 feet above the ground is 75 percent or more.
2. All 1-foot strata in the shrub layer are less than 15 percent stocked with vegetation.
3. Stand age is greater than 30 years unless overstory layer stocking by 1-foot strata is less than 40 percent.

Suitable habitats.

1. Vegetative stocking in 1-foot stratum of highest density above the 25-foot level:
   a. 0-24 percent (3)
   b. 25-49 percent (2)
   c. 50-74 percent (1)
2. Vegetative stocking in 1-foot stratum of highest density in the shrub layer:
   a. 50-100 percent (3)
   b. 30-49 percent (2)
   c. 15-29 percent (1)
3. Stand age:
   a. 0-10 years (3)
   b. 11-20 and 31 or more years (2)
   c. 21-30 years (1)

Habitat Rank Determination

Habitat rank	*Code*	*Total accumulated points*
Good	3	8-9
Acceptable	2	6-7
Poor	1	3-5
Unsuitable	0	0

Wood Thrush

Wood thrush breeding habitats are opposite to those of the prairie warbler. Mature, climax hardwood stands appear to be the preferred breeding habitat of the wood thrush, provided a light to moderate shrub or understory stratum is present (Bertin 1977; Brackbill 1943; DeGraaf 1976; James 1971; Johnston and Odum 1956; Shugart and James 1973; Willson 1974). Since the wood thrush nests at an average height of 10 feet aboveground (Bent 1949; McElroy 1974), the shrub and understory layers are important.

The habitat screening criteria for the wood thrush uses stand age, the presence of shrub and understory layers, and a well-developed overstory layer as the variables to determine whether a sample stand is classified as suitable or unsuitable. Meyers and Johnson's (1978) study indicates that the wood thrush is tolerant of a range of habitats from pine stands 25 to 30 years old to their favored mature hardwood stands. Several sources indicate that the wood thrush prefers the more mesic forest stands for breeding (Bent 1949; Bertin 1977; Shugart and James 1973). Hence, the ranking of suitable habitats uses forest type and the presence and type of water on the stand, in addition to the variables used to separate suitable and unsuitable habitats. The habitat screening criteria for the wood thrush are:

Unsuitable habitats.

1. Stand age is less than 25 years, unless there is 50 percent or better vegetative stocking in the 1-foot stratum of highest density in the overstory.
2. All 1-foot strata in the shrub and understory layers are less than 15 percent stocked with vegetation.
3. All 1-foot strata in the overstory layer are less than 30 percent stocked with vegetation.

Suitable habitats.

1. Forest type:
   a. Hardwood types, except oak-gum-cypress (3)
   b. Oak-pine types (2)
   c. Pine types and oak-gum-cypress (1)
2. Stand age:
   a. 75 years or more (3)
   b. 50-74 years (2)
   c. 0-49 years (1)
3. Vegetative stocking in 1-foot stratum of highest density in the shrub layer:
   a. 50 percent or more (3)
   b. 30-49 percent (2)
   c. 15-29 percent (1)
4. Vegetative stocking in 1-foot stratum of highest density in the understory layer:
   a. 50 percent or more (3)
   b. 30-49 percent (2)
   c. 15-29 percent (1)
5. Vegetative stocking in 1-foot stratum of highest density in the overstory layer:

a. 75 percent or more (3)
b. 50-74 percent (2)
c. 30-49 percent (1)

6. Presence of water:
   a. Permanent water on sample acre (3)
   b. Permanent water in stand adjacent to but not on sample acre (2)
   c. Temporary water on sample acre or in adjacent stand (1)

Habitat Rank Determination

Habitat rank	*Code*	*Total accumulated points*
Good	3	14-18
Acceptable	2	10-13
Poor	1	5-9
Unsuitable	0	0

Pine Warbler

Griscom and Sprunt (1957) state that the pine warbler is strictly a bird of the pine forests and is hardly ever seen far from pine trees it uses for nesting. Anderson and Shugart (1974a, 1974b) found that the pine warbler selects its habitat most strongly on the basis of number of canopy trees, size of canopy vegetation, and average size of understory vegetation. Pine warblers were most common in areas with a dense canopy and sparse understory. They occur at highest densities in pure pine stands, at lesser densities in oak-pine stands, and disappear with the pine trees in pure hardwood stands (Cleaveland 1973; Dickson and Segelquist 1979; Noble and Hamilton 1976; Oelke 1966; Parnell 1969; Reese 1976). Most adequately stocked pine stands 15 years old and older offer suitable habitat for pine warblers (Meyers and Johnson 1978).

The habitat screening criteria for the pine warbler incorporate three variables in identifying suitable habitats—forest type, stand age, and pine vegetative stocking in the overstory. The overstory layer is considered to begin at 20 feet from the ground for the pine warbler because of the relatively young age of some suitable habitats. Exclusion of forest types other than pine or oak-pine permits stands to be classified as suitable only if 25 percent or more of the tree stocking is made up of pine species. Suitable habitats are ranked on the basis of three variables—pine vegetative stocking above the 20-foot level, total pine basal-area stocking, and shrub and understory vegetative stocking. The most favorable habitats are those with the lowest shrub and understory layer stocking. Stand age is not used to rank suitable habitats, since evidence suggests that habitat suitability does not increase appreciably with stand maturity (Meyers and Johnson 1978). The screening criteria for the pine warbler are:

Unsuitable habitats.

1. Forest type is other than pine or oak-pine.
2. Stand age is less than 15 years, unless pine vegetative stocking in 1-foot stratum of highest density in the overstory is 40 percent or greater.
3. Pine vegetative stocking in all 1-foot strata more than 20 feet above ground is less than 30 percent.

Suitable habitats.

1. Pine vegetative stocking in 1-foot stratum of highest density above the 20-foot level:
   a. 75 percent or more (3)
   b. 50-74 percent (2)
   c. 30-49 percent (1)
2. Total pine basal area per acre:
   a. 60 square feet or more (3)
   b. 35-59 square feet (2)
   c. 10-34 square feet (1)
3. Vegetative stocking in 1-foot stratum of highest density in the shrub and understory layers:
   a. Less than 30 percent (3)
   b. 30-59 percent (2)
   c. 60 percent or more (1)

Habitat Rank Determination

Habitat rank	*Code*	*Total accumulated points*
Good	3	8-9
Acceptable	2	5-7
Poor	1	2-4
Unsuitable	0	0

Red-eyed Vireo

The red-eyed vireo is found to some extent in many forest conditions and probably has a somewhat broad environmental tolerance (Beals 1960). However, mature hardwood stands support the highest numbers of this bird, while pure pine stands do not provide suitable habitat (Bond 1957; DeGraaf 1976; James 1971; Johnston and Odum 1956; Kendeigh 1945; Lawrence 1953). Lawrence (1953) found no red-eyed vireos where less than 25 percent of the total basal area consisted of broadleaf trees. The presence of a well-developed overstory stratum is of major importance to the red-eyed vireo (Anderson and Shugart 1974a, 1974b; DeGraaf 1976) because it feeds on broadleaf canopy foliage insects (Bent 1950). But the presence of subcanopy stratification has also been shown to be of importance to red-eyed vireo occurrence (Anderson and Shugart 1974a, 1974b; James 1976; Lawrence 1953; Shugart and James 1973). Shrubs, saplings, and low tree branches are used by the red-

eyed vireo for nesting (Bent 1950), usually at 5 to 20 feet above ground.

The habitat screening criteria used in identifying suitable habitats include the percentage of total basal area comprised of hardwood species, stand age, and vegetative stocking in the overstory layer and layers below the overstory. Ranking of suitable habitats is based on the same criteria.

These criteria are:

Unsuitable habitats.

1. Less than 25 percent of the total basal area is made up of hardwood tree species.
2. Stand age is less than 20 years unless hardwood vegetative stocking in the 1-foot stratum of highest density in the overstory is 50 percent or more.
3. All 1-foot strata in the 5- to 30-foot layer are less than 15 percent stocked with vegetation.
4. All 1-foot strata in the overstory layer are less than 30 percent stocked with broadleaf vegetation.

Suitable habitats.

1. Proportion of total basal area made up of hardwood species:
   a. 75 percent or more (3)
   b. 50-74 percent (2)
   c. 25-49 percent (1)
2. Stand age:
   a. 70 years or more (3)
   b. 45-69 years (2)
   c. 0-44 years (1)
3. Vegetative stocking in 1-foot stratum of highest density in the midstory layer:
   a. 50 percent or more (3)
   b. 30-49 percent (2)
   c. 15-29 percent (1)
4. Vegetative stocking in 1-foot stratum of highest density in the understory layer:
   a. 50 percent or more (3)
   b. 30-49 percent (2)
   c. 15-29 percent (1)
5. Hardwood vegetative stocking in 1-foot stratum of highest density in the overstory layer:
   a. 75 percent or more (3)
   b. 50-74 percent (2)
   c. 30-49 percent (1)

Habitat Rank Determination

Habitat rank	*Code*	*Total accumulated points*
Good	3	13-15
Acceptable	2	9-12
Poor	1	4-8
Unsuitable	0	0

Pileated Woodpecker

The pileated woodpecker prefers dense, mature forests for its breeding habitats (Conner and Adkisson 1977; Hardin and Evans 1977). However, coniferous and deciduous forests with medium-sized sawtimber (15 to 18 inches diameter at breast height, d.b.h.) will provide adequate pileated nest trees if some of the trees are decayed or dead (Conner and others 1975). The presence of decay in pileated nest trees is apparently necessary to allow cavity excavation into the heartwood. Conner and others (1976) found that all pileated woodpecker nest trees examined in southwest Virginia were infected by fungal heartrots. Old-growth stands provide optimal habitat because these fungal heartrots have had time to infest numerous trees and the trees are large enough to contain large cavities. But somewhat younger stands can provide adequate habitat, especially those with large residual trees left from prior timber cuttings.

Stand density and the presence of nearby water appears to have an effect on the suitability of a stand for pileated breeding habitat. Conner and Adkisson (1977) and Conner and others (1975) found pileated nest trees only in dense stands (137 square feet of basal area per acre) in southwest Virginia. Pileated nest trees are almost always near a supply of water (Conner and Adkisson 1977; Hooper 1967; Hoyt 1957). The percentage of the area around their nests in forest cover is also important because the pileated tends to favor the heavily forested areas and reject the lightly forested, highly dissected ones (Conner and Adkisson 1977; Sprunt and Chamberlain 1970).

The variables used to identify suitable pileated woodpecker habitat are stand age, vegetative stocking in the overstory, and percentage of forest cover. The overstory layer begins at the 40-foot level for the evaluation of this species' habitat. Variables used in ranking suitable habitats include the presence of water on or near the stand, the presence of medium to large sawtimber trees containing appreciable decay, and the three variables listed above. The criteria for evaluating pileated woodpecker habitat are:

Unsuitable habitats.

1. Stand age is less than 40 years for bottomland forest types and less than 50 years for all other types.
2. All 1-foot strata above the 40-foot vertical level are less than 25 percent stocked with vegetation.
3. A 450-acre circular area with the sample stand as the center is less than 36 percent forest land.

Suitable habitats.

1. Stand age:
   a. Bottomland and pine types—80 years or more; other types—99 years or more (3)
   b. Bottomland types—60 to 79 years; pine types—65 to 79 years; other types—75 to 98 years (2)
   c. Bottomland types—40 to 59 years; pine types—50 to 64 years; other types—50 to 74 years (1)
2. Vegetative stocking in 1-foot stratum of highest density above the 40-foot level:
   a. 80 percent or more (3)
   b. 50-79 percent (2)
   c. 25-49 percent (1)
3. Presence of water:
   a. Permanent water on sample acre (3)
   b. Permanent water in stand adjacent to but not on sample acre (2)
   c. Temporary water on sample acre or in adjacent stand (1)
4. Percent forest land in 450-acre area surrounding sample acre:
   a. 76 percent or more (3)
   b. 56-75 percent (2)
   c. 36-55 percent (1)
5. Square feet of basal area per acre in trees 15 inches d.b.h. and larger with 20 percent or more volume loss due to decay:
   a. 8 or more (3)
   b. 4-7 (2)
   c. 0-3 (1)

Habitat Rank Determination

Habitat rank	*Code*	*Total accumulated points*
Good	3	13-15
Acceptable	2	9-12
Poor	1	4-8
Unsuitable	0	0

Downy Woodpecker

The downy woodpecker is found in yards, gardens, and roadsides as well as in numerous forested conditions. In forests, its breeding habitats are found in earlier successional stages than are those of the pileated woodpecker (Bond 1957; Conner and Adkisson 1977). Thus, downy nests are located in stands of smaller trees and lower basal area than are those of the pileated (Conner and others 1975).

Anderson and Shugart (1974a, 1974b) found that downy occurrence was highly correlated with the number of sapling trees—stands with high numbers of sapling trees supported a higher number of downy woodpeckers than did stands with few sapling trees. Downies apparently spend much of their time foraging on these small trees in the subcanopy strata (Williams 1975). This habit allows them to breed in recently timbered areas provided that enough nest trees are available (Ambrose 1975). Adequate nesting sites are provided by snags and live trees infected with fungal heartrots (Conner and others 1976). Conner and others (1975) state that stands with trees averaging 8 to 12 inches d.b.h. will provide adequate nesting sites if some of the trees are decayed.

The variables considered most important to downy occurrence and used to identify suitable habitats include stand age, vegetative stocking in the understory and midstory layers, the presence of residual trees in young stands, and the number of saplings per acre. Variables used in ranking suitable habitats include stand age, the number of saplings per acre, basal area per acre, and the presence of trees 9 inches d.b.h. and larger containing appreciable decay. The criteria are:

Unsuitable habitats.

1. Stand age is 11 to 29 years.
2. There are less than 200 saplings per acre.
3. All 1-foot strata in the understory or midstory layers are less than 15 percent stocked with vegetation.
4. For stands age 10 or less, there is less than 10 square feet of basal area per acre in trees 9 inches d.b.h. and larger.

Suitable habitats.

1. Stand age:
   a. 60 years or more (3)
   b. 45-59 and 0-10 years (2)
   c. 30-44 years (1)
2. Number of saplings per acre:
   a. 900 or more (3)
   b. 500-899 (2)
   c. 200-499 (1)
3. Square feet of basal area per acre:
   a. 35-70 (3)
   b. 20-34 or 71-90 (2)
   c. Less than 20, or more than 90 (1)
4. Square feet of basal area per acre in trees 9 inches d.b.h. and larger with 20 percent or more volume loss due to decay:
   a. 8 or more (3)
   b. 4-7 (2)
   c. 0-3 (1)

Habitat Rank Determination

Habitat rank	*Code*	*Total accumulated points*
Good	3	10-12
Acceptable	2	7-9

Poor	1	4-6
Unsuitable	0	0

Brown-headed Nuthatch

The brown-headed nuthatch prefers the open, mature pine forests of the Southeastern United States for its breeding habitat. Younger pine forests and mixed pine-hardwood stands provide less favorable but suitable habitats, while extremely young pine stands and pure hardwood stands provide no suitable habitat (Bent 1948; Cleaveland 1973; Johnston and Odum 1956; McElroy 1974; Meyers and Johnson 1978; Noble and Hamilton 1976; Oelke 1966; Scott and others 1977; Sprunt and Chamberlain 1970). The brown-headed nuthatch nests low to the ground in cavities excavated in decayed tree stubs, stumps, or fence posts (Norris 1958). They are often found in burned-over pine forests since fire creates the preferred open understory and needed nesting sites (Bent 1948; McElroy 1974; Sprunt and Chamberlain 1970).

The habitat variables deemed most important to brown-headed nuthatch occurrence are stand age, percentage of total basal area made up of pine species, and pine vegetative stocking in the overstory layer. These variables are used to identify suitable habitats. Additional variables used in ranking suitable habitats are vegetative stocking in the shrub and understory strata and the occurrence of fire in the recent past. The habitat screening criteria for the brown-headed nuthatch are:

Unsuitable habitats.

1. Stand age is less than 20 years.
2. Less than 50 percent of the total basal area is made up of pine species.
3. Pine vegetative stocking in all 1-foot strata in the overstory is less than 40 percent.

Suitable habitats.

1. Stand age:
   a. 60 years or more (3)
   b. 40-59 years (2)
   c. 20-39 years (1)
2. Proportion of total basal area made up of pine species:
   a. 80 percent or more (3)
   b. 65-79 percent (2)
   c. 50-64 percent (1)
3. Vegetative stocking in 1-foot stratum of highest density in the 2- to 15-foot vertical layer:
   a. 0-30 percent (3)
   b. 31-60 percent (2)
   c. 61 percent or more (1)
4. Pine vegetative stocking in 1-foot stratum of highest density in the overstory layer:
   a. 80 percent or more (3)
   b. 60-79 percent (2)
   c. 40-59 percent (1)
5. History of fire occurrence on sample stand:
   a. Burned within past year (3)
   b. Burned 1 to 3 years ago (2)
   c. Burned over 3 years ago, or no history of fire (1)

Habitat Rank Determination

Habitat rank	*Code*	*Total accumulated points*
Good	3	13-15
Acceptable	2	9-12
Poor	1	5-8
Unsuitable	0	0

Prothonotary Warbler

The prothonotary warbler limits its choice of breeding habitats to swamps, river bottoms, and other low-lying, frequently flooded areas (Bent 1953; Parnell 1969). Nests are placed in natural cavities and woodpecker holes in snags, stumps, and decayed cypress knees (Griscom and Sprunt 1957; Simpson 1969). The presence of standing or running water near the nest site appears to be of utmost importance for the prothonotary. For instance, Walkinshaw (1953) found in a Michigan study that all 84 established territories of this warbler were in the immediate vicinity of running or standing water or in easily flooded locations. The nests were usually shaded most of the day, making the presence of a thick tree canopy a prerequisite. Other attributes of prothonotary warbler habitat include the absence of a dense shrub layer and intermediate to mature successional ages (James 1971).

In South Carolina and throughout the Southeast, prothonotary warblers occur at highest densities in the coastal swamps, but are also found in flood plain forests in the Piedmont regions (Reese 1976; Simpson 1969; Sprunt and Chamberlain 1970). The habitat screening criteria should handle identification of suitable habitats in either area. The criteria used to separate suitable and unsuitable habitats are numerous. They include physiographic class, presence of water or proximity to water, shrub layer vegetative stocking, overstory layer vegetative stocking, and stand age. These same variables, excepting physiographic class, are used to rank suitable habitats. The criteria are:

Unsuitable habitats.

1. Physiographic class is other than the following: stream margin, deep swamp, cypress strand, small drain, cypress pond, or willow heads and strands.
2. There is no water (permanent or temporary) recorded on the sample acre or in the adjacent stand, or if the plot is not within 300 feet of a stream

greater than 30 feet in width.

3. Vegetative stocking in 1-foot stratum of highest density in the shrub layer is greater than 60 percent.

4. All 1-foot strata in the overstory layer are less than 40 percent stocked with vegetation.

5. Stand age is less than 30 years.

Suitable habitats.

1. Presence of water or proximity to streams:
   a. Permanent water on sample acre, or less than 119 feet from stream (3)
   b. Permanent water in stand adjacent to but not on sample acre, or 119 to 200 feet from stream (2)
   c. Temporary water on sample acre or adjacent stand, or 201 to 300 feet from stream (1)
2. Vegetative stocking in 1-foot stratum of highest density in the shrub layer:
   a. 0-20 percent (3)
   b. 21-40 percent (2)
   c. 41-60 percent (1)
3. Vegetative stocking in 1-foot stratum of highest density in the overstory layer:
   a. 80 percent or more (3)
   b. 60-79 percent (2)
   c. 40-59 percent (1)
4. Stand age:
   a. 80 years or more (3)
   b. 50-79 years (2)
   c. 30-49 years (1)

Habitat Rank Determination

Habitat rank	*Code*	*Total accumulated points*
Good	3	10-12
Acceptable	2	7-9
Poor	1	4-6
Unsuitable	0	0

Eastern Bluebird

The eastern bluebird typically inhabits open pine stands and clearings, and nests in old woodpecker holes in standing dead trees (Burleigh 1958; Scott and others 1977; Thomas 1946). The early stages of succession following field abandonment or clearcutting are beneficial to the eastern bluebird (Shugart and James 1973). Conner and Adkisson (1974, 1975) found that 1-year-old clearcut areas provide excellent breeding habitat for bluebirds if nest cavities are available. Clearcuts up to 12 years old provide suitable habitat. As stands grow older the vegetation grows taller and more dense, thus detracting from its suitability as bluebird habitat. Bluebirds are known to select areas with abundant open ground (Thomas 1946). Heard (1979) studied eastern bluebird nesting success in clearcuts of varying ages in eastern North Carolina and found that nesting success in artificial boxes placed in 1- to 3-year-old clearcuts was more than double that of boxes placed in 4- to 8-year-old pine stands. She also confirmed the observations of other authors (Pinkowski 1976; Scott and others 1977) that eastern bluebirds readily nest in the savannahlike habitats of older pine stands.

The habitat criteria used in identifying and ranking eastern bluebird habitats reflect the two stages of suitable habitats. Stands falling between the early clearcut stages and the somewhat older pine stands are excluded. Other variables used to identify suitable habitats include forest type, vegetative stocking in the understory layer, basal area per acre, and vegetative stocking in the overstory layer. Only three variables are used to rank suitable habitats—stand age, vegetative stocking in the understory layer, and the history of fire occurrence. Fire maintains the favored open ground and creates potential nesting substrates. The habitat screening criteria for the eastern bluebird are:

Unsuitable habitats.

1. Stand age is 13 to 19 years.

2. Forest type is not pine for stands 20 years old and greater.

3. For stands 0 to 12 years old, vegetative stocking in the 1-foot stratum of highest density in the understory layer is 60 percent or greater.

4. For stands 20 years old and greater, vegetative stocking in the 1-foot stratum of highest density in the understory layer is 40 percent or greater.

5. Basal area per acre is greater than 60 square feet.

6. Vegetative stocking in 1-foot stratum of highest density in the overstory layer is greater than 50 percent.

Suitable habitats.

1. Stand age:
   a. 0-3 or 60 years and more (3)
   b. 4-8 or 40-59 years (2)
   c. 9-12 or 20-39 years (1)
2. Vegetative stocking in the 1-foot stratum of highest density in the understory layer:
   a. 0-15 percent (3)
   b. 16-30 percent (2)
   c. 31 percent or more (1)
3. History of fire in sample stand:
   a. Within past year (3)
   b. 1 to 3 years ago (2)
   c. Over 3 years ago, or no history of fire in stand (1)

Habitat Rank Determination

Habitat rank	*Code*	*Total accumulated points*
Good	3	8-9
Acceptable	2	6-7
Poor	1	3-5
Unsuitable	0	0

RESULTS

A FORTRAN program was written incorporating the criteria presented. The program evaluated each RRE forest sample in South Carolina, using the available habitat data, and ranked each sample stand in terms of its suitability for breeding habitat for the nine nongame bird species. Summary cards for each plot were produced with the rankings along with other basic data about the stand. These summary cards were used for compiling and evaluating the data. The estimates of the extent, relative condition, and distribution of habitat are presented in this section.

When interpreting these data, the reader should keep in mind that the criteria used to estimate area of habitat are based on general habitat descriptions, with modifications to allow incorporation of RRE data. For this reason, the results presented are intended to be examples and not bold forecasts of the acreages in South Carolina on which one should find each of the nine species. The results do show some expected differences between species, ownership, and regions within the State.

Habitat Extent and Conditions

The acreages of habitat by suitability and species are presented in table 2. The results seem consistent with the qualitative descriptions of habitat and species abundance obtained from the literature. For instance, the eastern bluebird and the prothonotary warbler are probably the most restrictive of the nine species in their selection of habitat; these two species have the least acreage of suitable habitat. The prairie warbler is somewhat less restrictive, resulting in about 25 percent of the forest land being classified as suitable. However, most of this suitable acreage was ranked as either good or acceptable habitat. The pileated woodpecker and the brown-headed nuthatch, both species of some concern to ornithologists, have between 26 and 30 percent of the commercial forests in suitable habitat. However, both species have 10 percent or less of their total suitable acreage ranked as good habitat. The species with the most suitable habitat include the downy woodpecker, wood thrush, red-eyed vireo, and the pine warbler. The literature suggests that these species may have more tolerance to habitat variability than do the other five species. This tolerance is probably reflected by the screening criteria. Various natural and man-related forces may have combined to create or sustain abundant suitable habitat for these and other species.

Habitat Distribution

Computer generated habitat maps, based on actual plot locations, for each of the nine species

Table 2.—Acreage of suitable and unsuitable nongame bird habitat, by suitability rank and species, South Carolina, 1978

Species	Total	Suitability rank			
		Good	Acceptable	Poor	Unsuitable
	Thousand acres				
Prairie warbler	12,502.9	1,165.6	1,246.8	759.5	9,331.0
Wood thrush	12,502.9	646.2	3,368.2	2,135.5	6,353.0
Pine warbler	12,502.9	1,823.0	2,633.1	825.0	7,221.8
Red-eyed vireo	12,502.9	1,418.9	3,400.4	659.9	7,023.7
Pileated woodpecker	12,502.9	329.0	1,651.1	1,228.1	9,294.7
Downy woodpecker	12,502.9	431.1	3,760.9	2,541.7	5,769.2
Brown-headed nuthatch	12,502.9	101.5	2,680.5	933.9	8,787.0
Prothonotary warbler	12,502.9	606.9	661.8	42.2	11,192.0
Eastern bluebird	12,502.9	147.4	613.1	731.7	11,010.7

(figs. 3-11) show the distribution of good, acceptable, and poor habitat in South Carolina. Although these maps also reflect the habitat acreage given in table 2, their greatest value is in identifying concentrations of suitable habitat for a particular species as well as areas where suitable habitat is sparse or absent.

Most of the nine species exhibit some differences in habitat distribution. Those species that are most restrictive in their selection of habitat show the most striking differences. In this study, these species include the prairie warbler, pileated woodpecker, brown-headed nuthatch, prothonotary warbler, and the eastern bluebird. These species also have the smallest acreage of suitable habitat.

The prairie warbler (see fig. 3) has more abundant habitat in the Coastal Plain region, where several concentrations are located, than in the Piedmont and mountainous regions. Stands sparsely stocked with trees reaching into the overstory layer combined with dense vegetative stocking in the shrub layers are more abundant in the Coastal Plain region than in the Piedmont. Suitable habitat for the pileated woodpecker (see fig. 7) is concentrated in the Coastal Plain and the small mountainous area. These concentrations are caused by the older stand ages in these two regions. In the Coastal Plain, the older stands, and thus the better pileated habitat, are located in the swamps and river bottoms. Suitable habitat for the brown-headed nuthatch (see fig. 9) is fairly uniformly distributed across the State with the exception of the northwest Piedmont and mountains, where suitable habitat is less dense. However, about 84 percent of the good habitat is located in the Coastal Plain. Only 16 percent of the prothonotary warbler habitat (see fig. 10) is located in the Piedmont. In the Coastal Plain, suitable habitat is heavily concentrated along the major rivers and in the swamps. Suitable eastern bluebird habitat is about proportionally distributed throughout the State in terms of total acreage, but the Coastal Plain has more noticeable concentrations of acceptable to good habitat (see fig. 11).

DISTRIBUTION OF SUITABLE
PRAIRIE WARBLER HABITAT
BY SUITABILITY CLASS, SOUTH CAROLINA, 1978

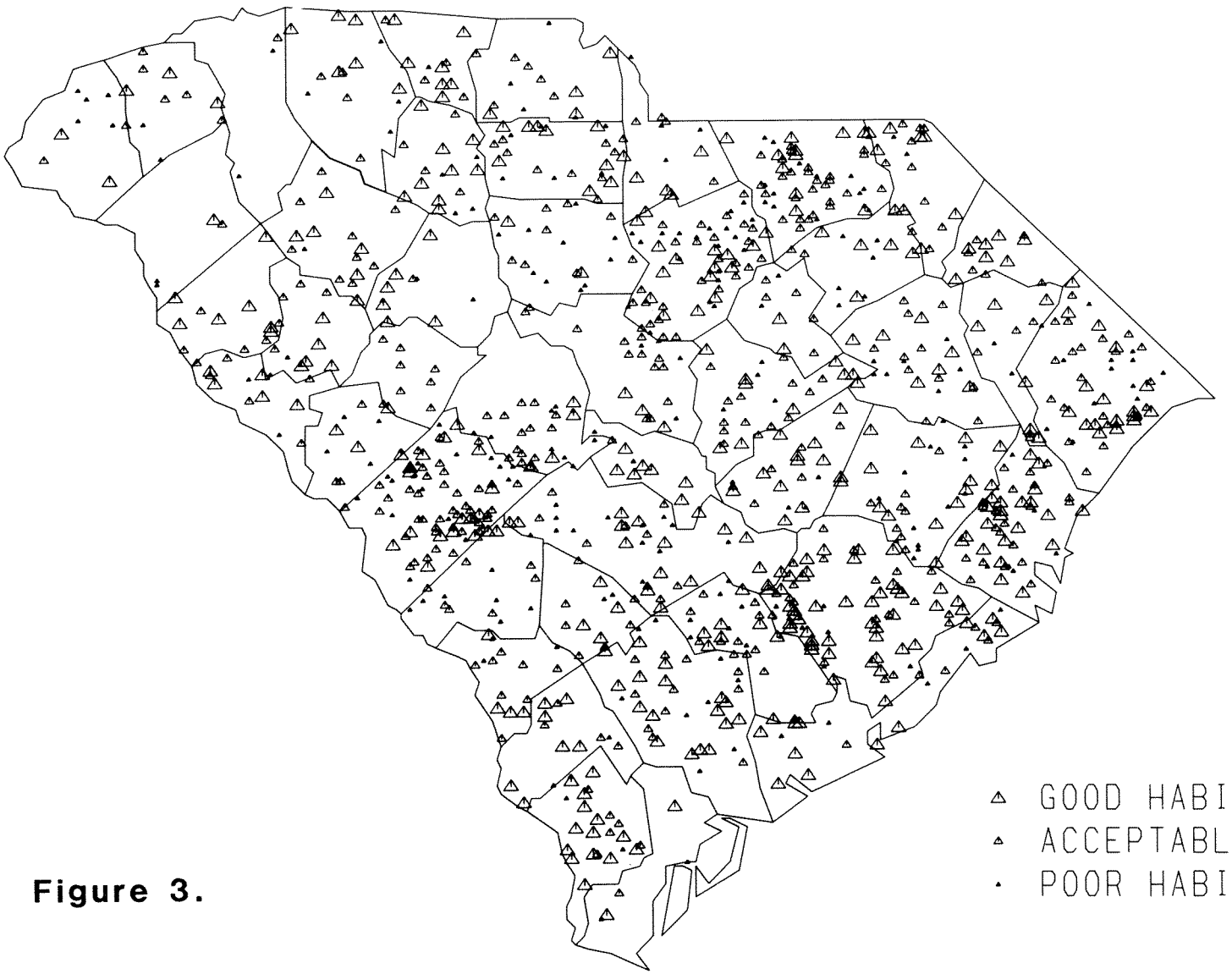

Figure 3.

DISTRIBUTION OF SUITABLE
WOOD THRUSH HABITAT
BY SUITABILITY CLASS, SOUTH CAROLINA, 1978

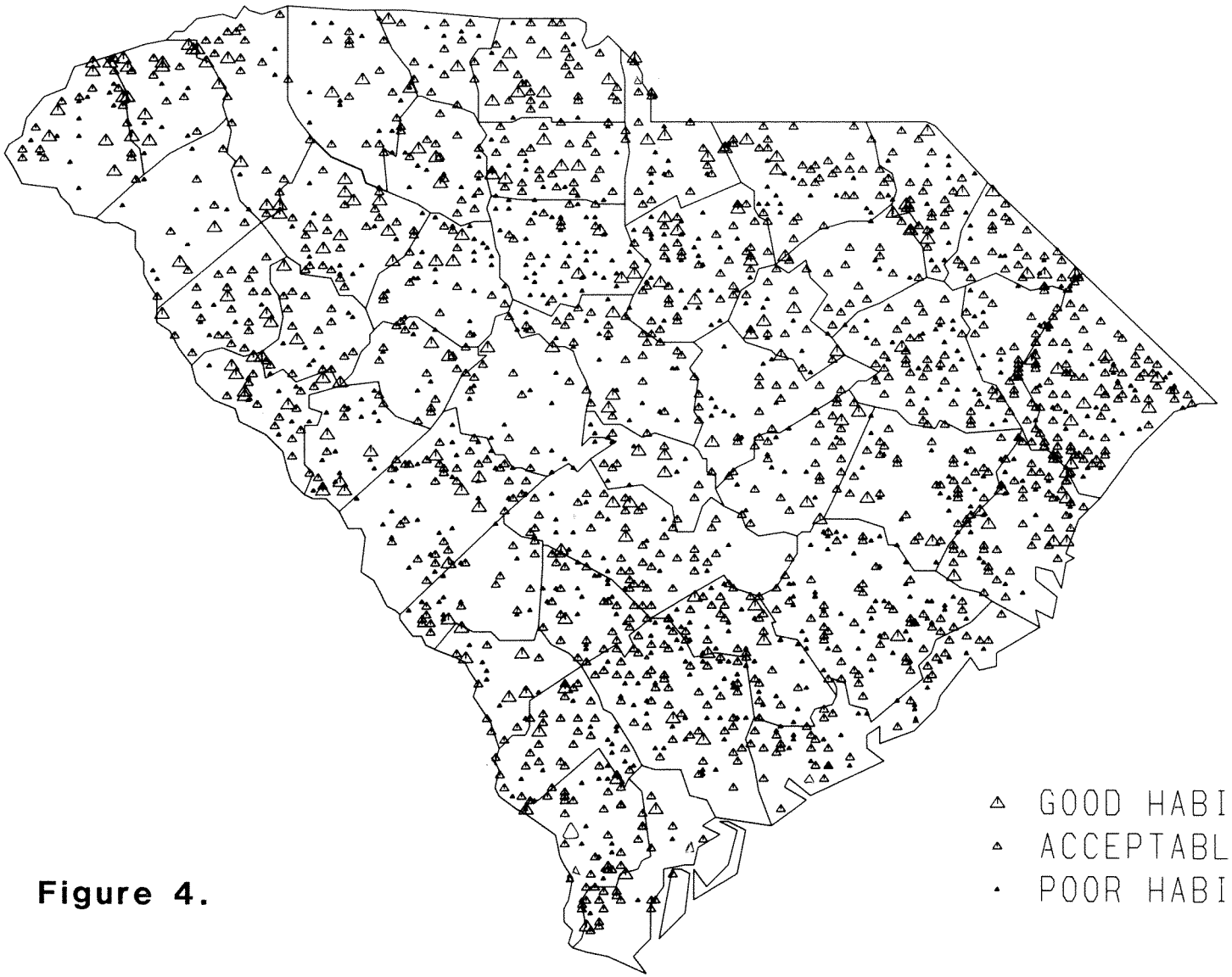

Figure 4.

DISTRIBUTION OF SUITABLE
PINE WARBLER HABITAT
BY SUITABILITY CLASS, SOUTH CAROLINA, 1978

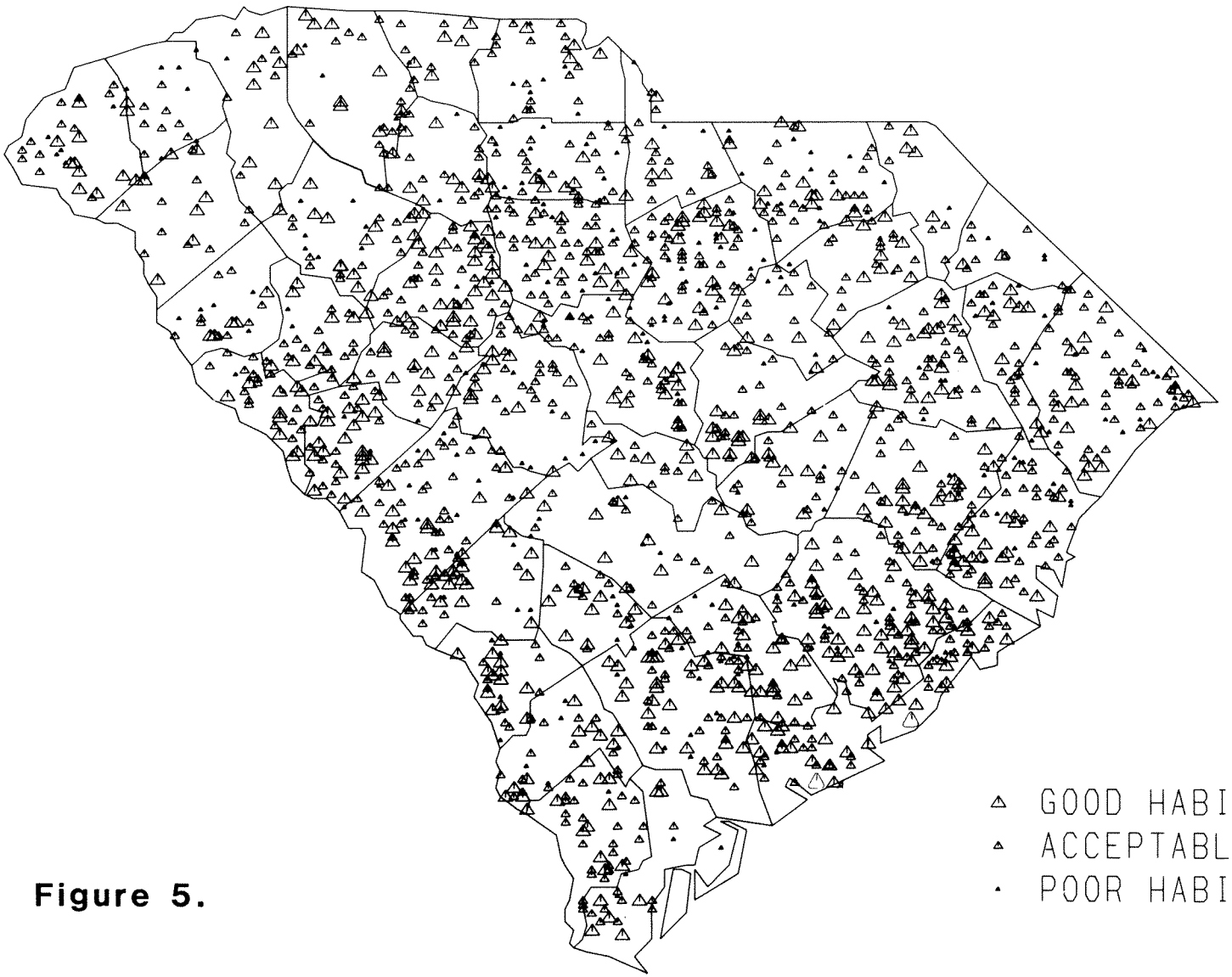

Figure 5.

DISTRIBUTION OF SUITABLE
RED-EYED VIREO HABITAT
BY SUITABILITY CLASS, SOUTH CAROLINA, 1978

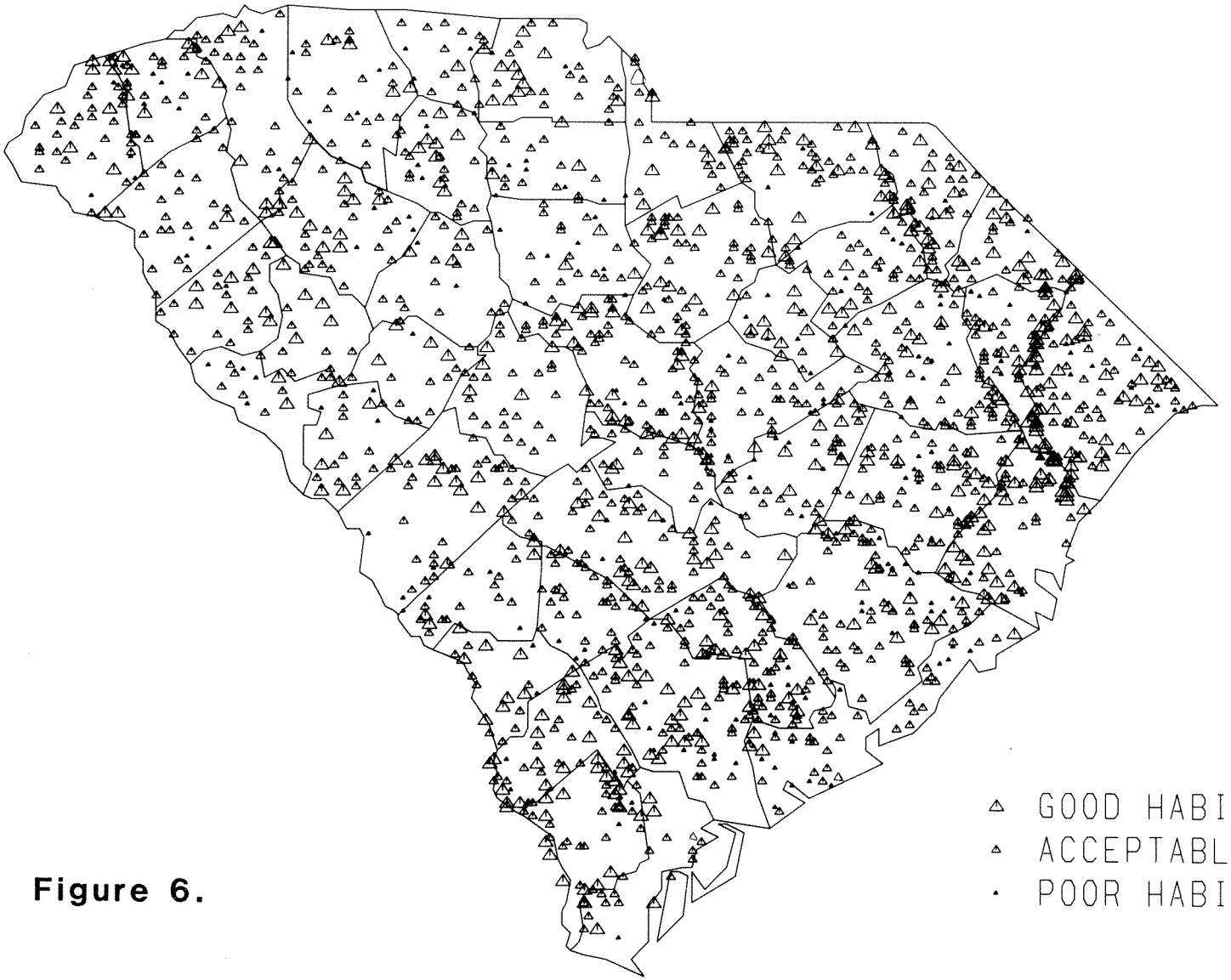

Figure 6.

DISTRIBUTION OF SUITABLE
PILEATED WOODPECKER HABITAT
BY SUITABILITY CLASS, SOUTH CAROLINA, 1978

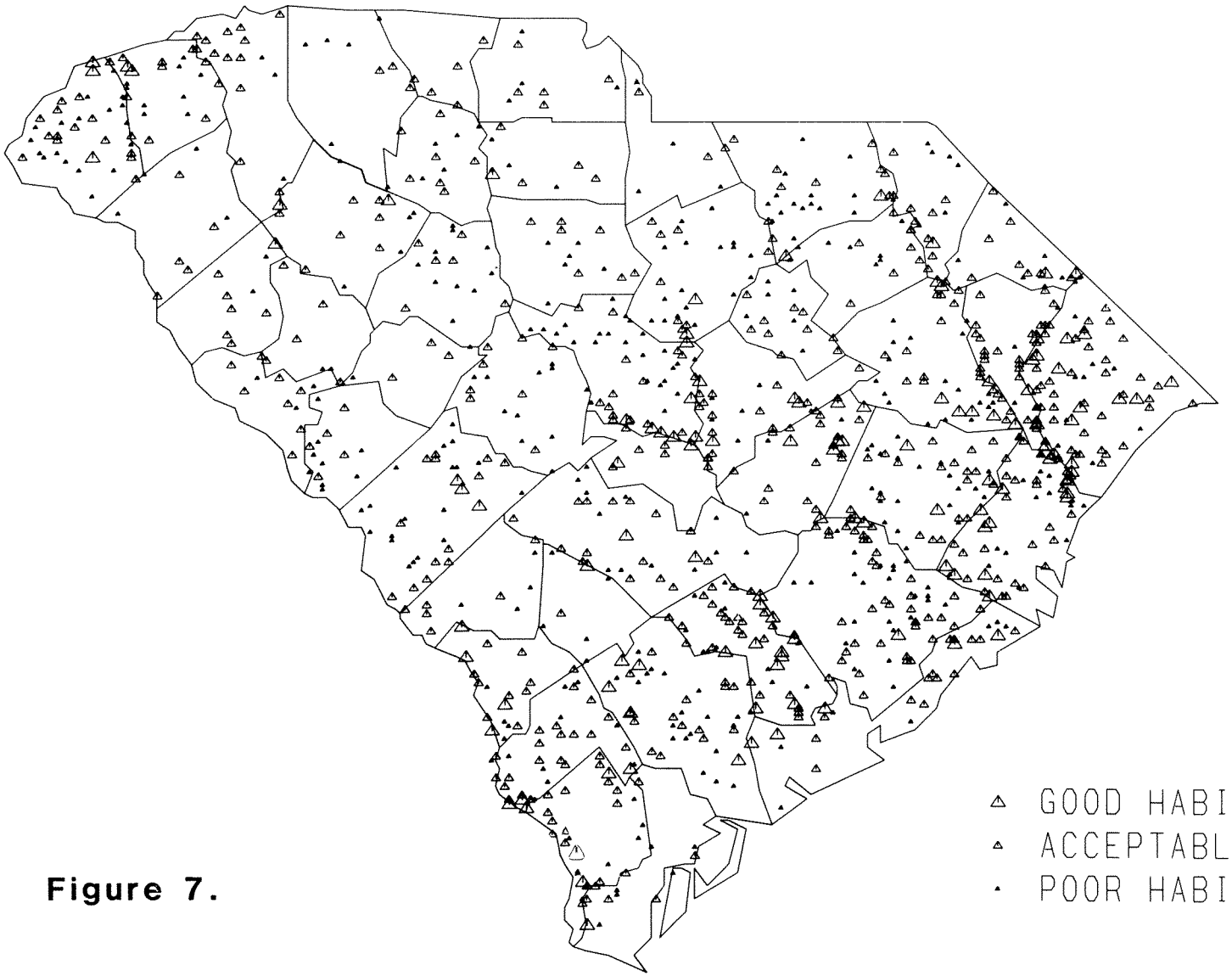

Figure 7.

DISTRIBUTION OF SUITABLE
DOWNY WOODPECKER HABITAT
BY SUITABILITY CLASS, SOUTH CAROLINA, 1978

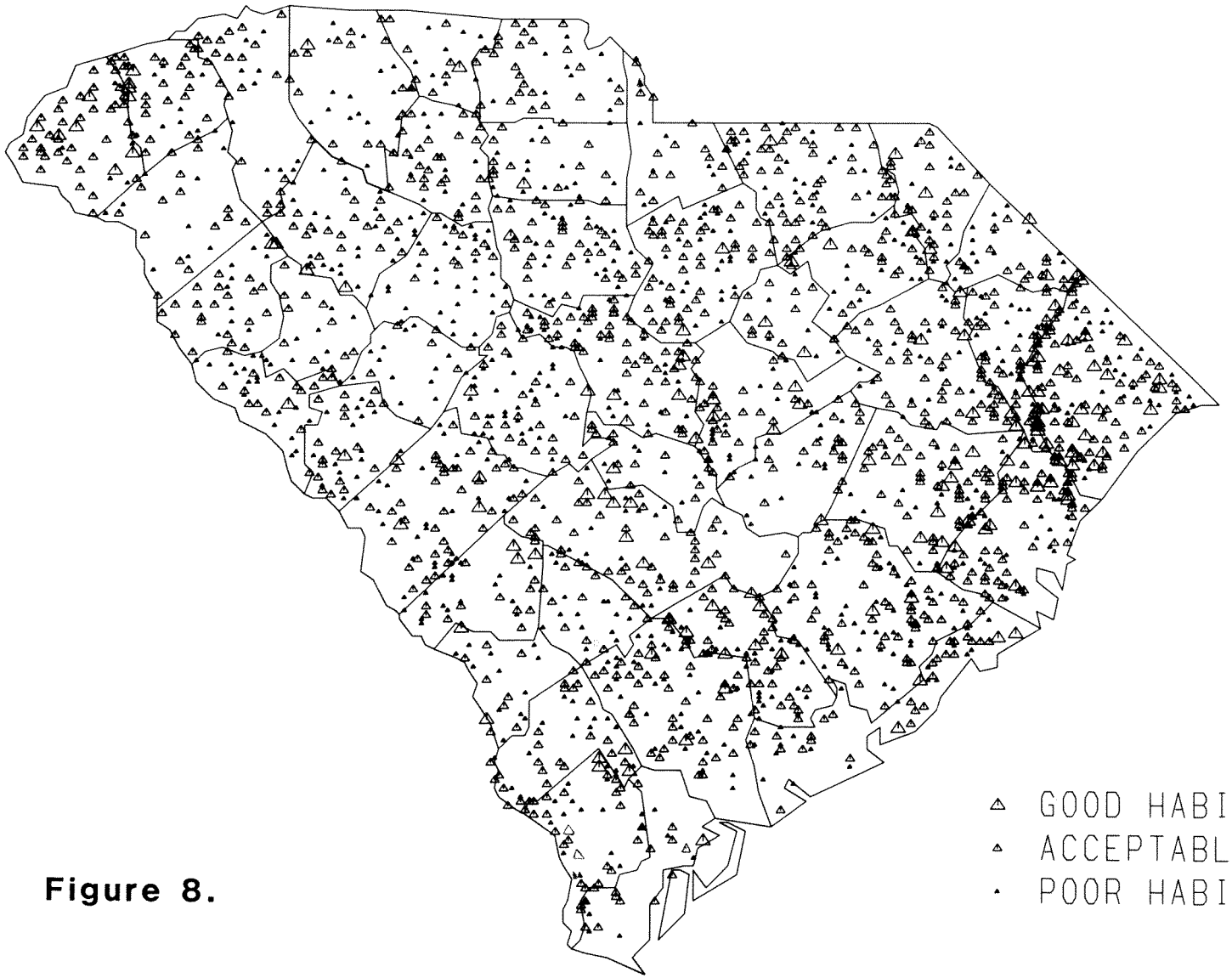

Figure 8.

DISTRIBUTION OF SUITABLE
BROWN-HEADED NUTHATCH HABITAT
BY SUITABILITY CLASS, SOUTH CAROLINA, 1978

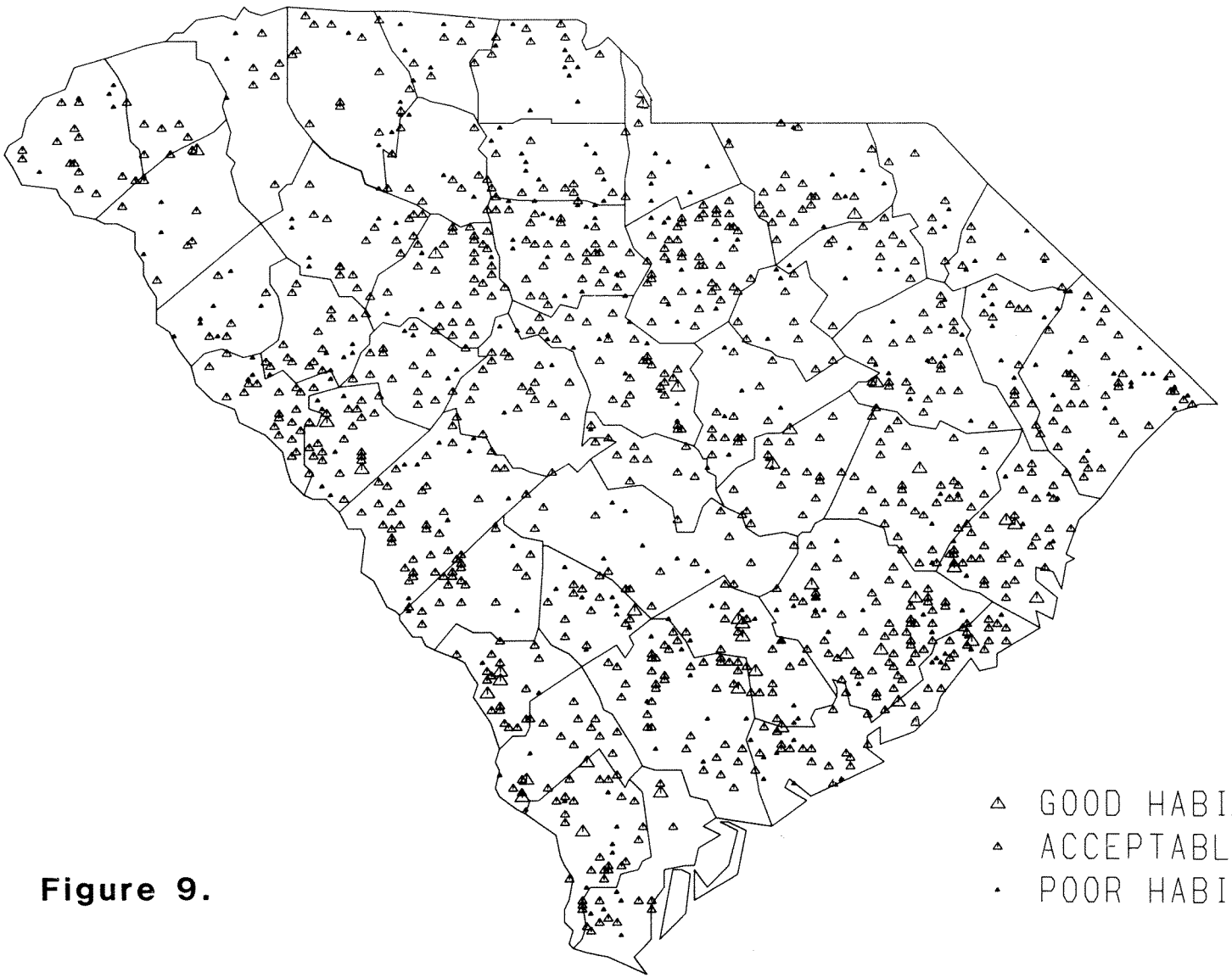

Figure 9.

DISTRIBUTION OF SUITABLE
PROTHONOTARY WARBLER HABITAT
BY SUITABILITY CLASS, SOUTH CAROLINA, 1978

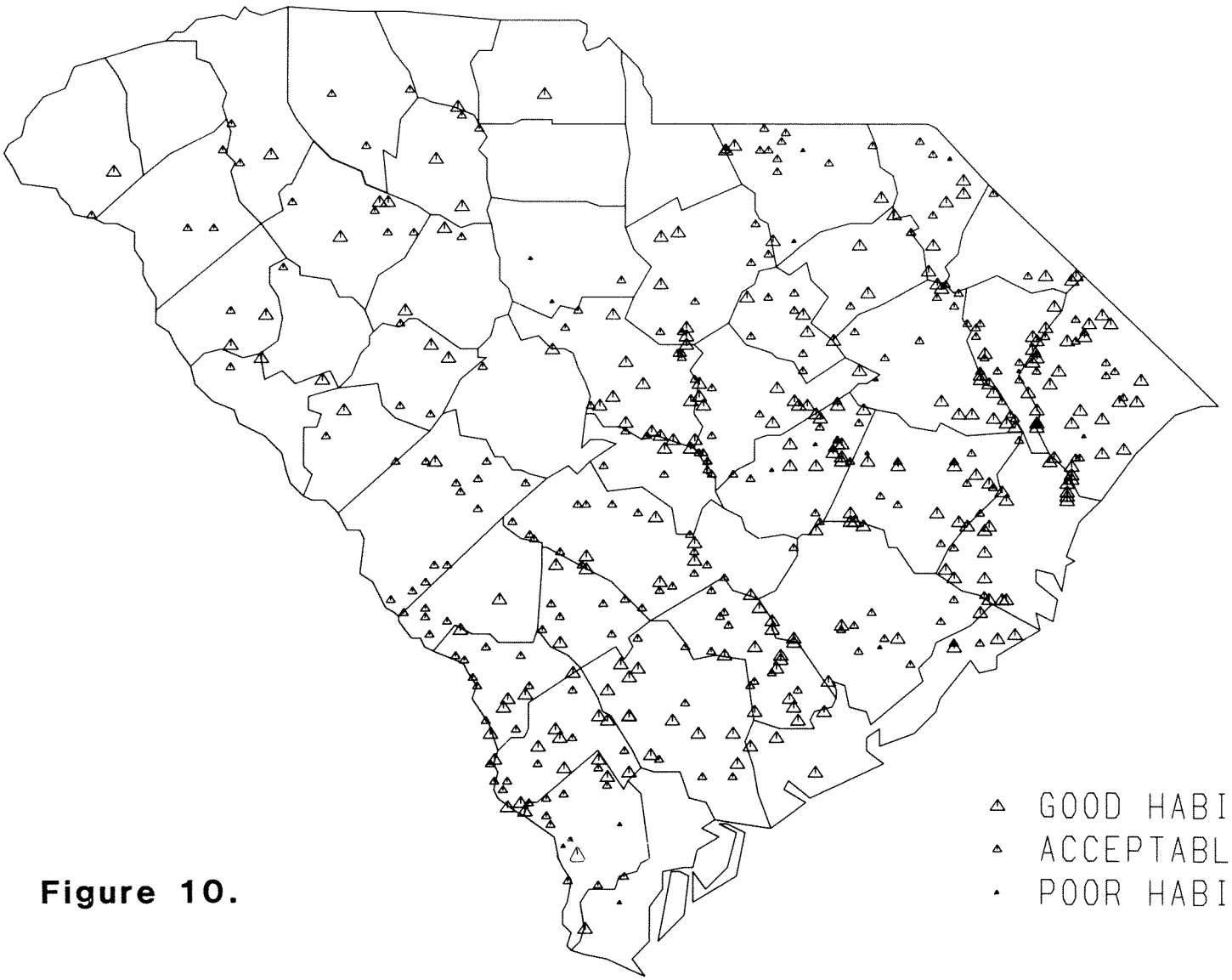

Figure 10.

DISTRIBUTION OF SUITABLE
EASTERN BLUEBIRD HABITAT
BY SUITABILITY CLASS, SOUTH CAROLINA, 1978

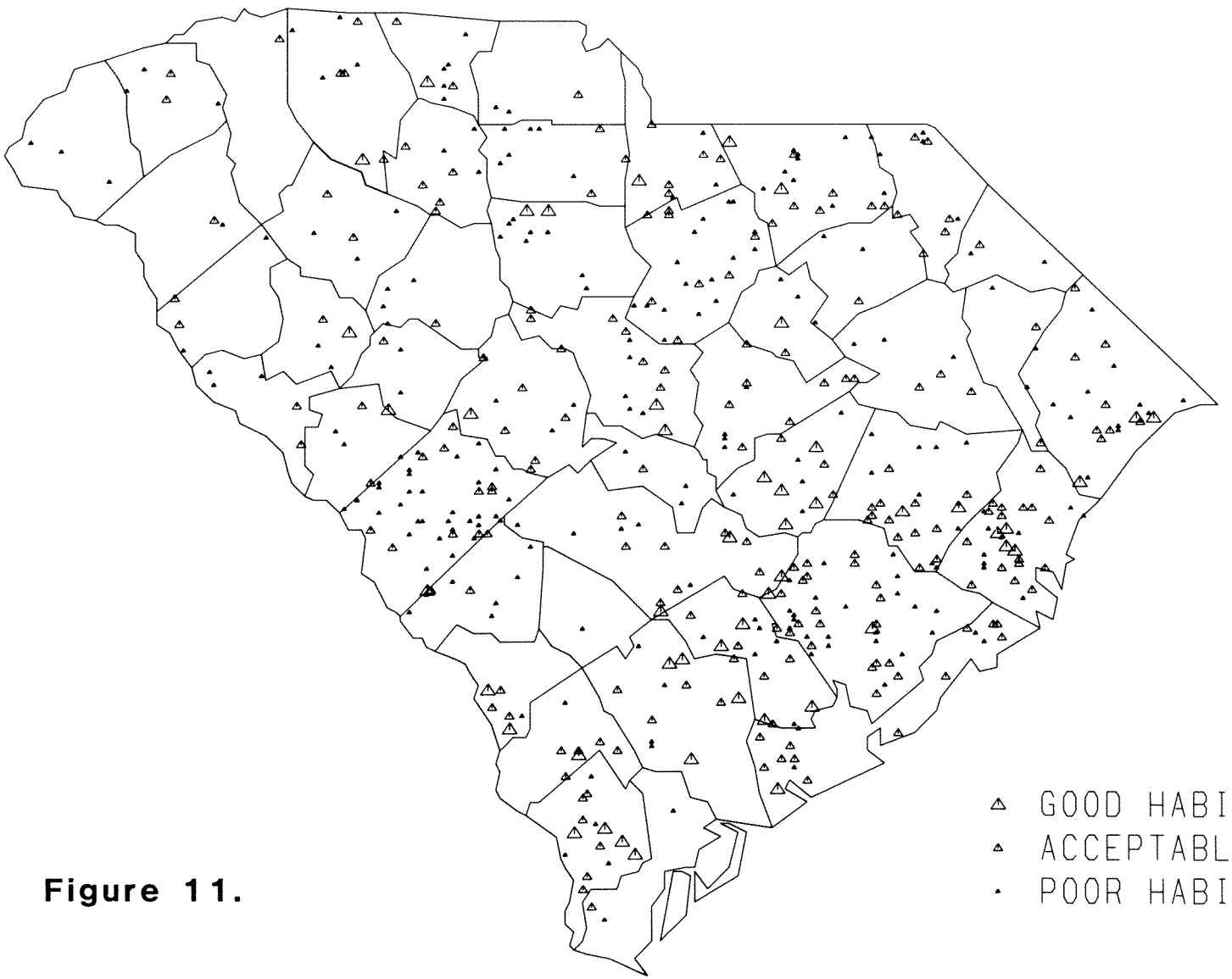

Figure 11.

The ownership of commercial forest land is an important factor in assessing the nontimber resource, as it has been for timber assessments for decades. Varying levels of management between the ownership groups result in differences in wildlife habitat as well as in timber characteristics. The physiography of the forest lands controlled by each ownership group can also affect the kinds and amount of wildlife habitat. Many of these differences show up when we look at the distribution of suitable nongame bird habitat by ownership class (table 3). The first column shows the percentage of all commercial forests that are owned by each ownership group. These percentages are used for comparison with similar percentages for suitable habitat for each of the bird species.

National Forests in South Carolina comprise only 4.6 percent of the commercial forest land (Sheffield 1979). These lands provide a higher than average percentage of suitable habitat for the pileated woodpecker, brown-headed nuthatch, pine warbler, and downy woodpecker; however, they provide considerably less than 4.6 percent of the suitable habitat for the prairie warbler, eastern bluebird, and prothonotary warbler. National Forests have a higher proportion of pine forest types, older stands, and upland physiographic classes than does the State as a whole (Sheffield 1979), which accounts for many of these differences. Forest lands controlled by other public agencies tend to be most favorable for pine stand dwellers (the pine warbler and the brown-headed nuthatch) and least favorable for those birds restricted to hardwood types (red-eyed vireo).

Comparison of the commercial forest and habitat percentages for forest industry lands reveals several differences. Forest industries control 18.6 percent of the commercial forests but provide 25 percent of the prairie warbler habitat, 29.1 percent of the eastern bluebird habitat, and 22.8 percent of the prothonotary warbler habitat. In contrast, only 13.3 percent of the red-eyed vireo habitat is located on forest industry lands. These findings probably result from the large acreage of industry land in young-age classes and pine forest types. Almost 39 percent of the total acreage classified as deep swamps in South Carolina is owned by forest industries, accounting for the abundant prothonotary warbler habitat. The forest industry percentage for the eastern bluebird habitats may be somewhat inflated relative to the other ownerships because the presence of cavities and snags was not used as a requirement. The intensive management practiced by forest industries often eliminates these nesting sources. Adequate data for cavities and snags on cutover forest lands will be available in subsequent inventories.

The two private groups, farmer and miscellaneous private, represent an intermediate management level between the two extremes of National Forests and forest industry. As a result, few major differences appear between the percentage of commercial forest land and suitable nongame bird habitat.

The relative quality of the habitat classified as suitable for each ownership is presented in table 4. The quality ranking for each species and ownership was calculated by summing all the numerical ranking codes for each species and dividing by the total number of suitable plots for that species and ownership. This calculation results in a code ranging from 1.0 to 3.0 and represents the average quality of only the suitable habitat, regardless of the total acreage involved. An average quality for each species across all owners provides a basis for comparison.

The differences between the ownership groups

Table 3.—Distribution of commercial forest land, by ownership class, and of suitable nongame bird habitat, by ownership class and species, South Carolina, 1978

Ownership class	All commercial forests	Species[1]								
		PRWA	WOTH	PINW	REVI	PIWO	DOWO	BRNU	PROW	EABL
	Percent									
National Forest	4.6	2.8	5.3	6.5	4.3	8.4	5.8	7.6	3.4	3.0
Other public	4.1	3.6	3.2	4.7	2.5	3.8	3.4	5.3	3.5	3.6
Forest industry[2]	18.6	25.0	15.6	17.1	13.3	16.7	14.5	16.7	22.8	29.1
Farmer	36.0	33.4	37.0	34.1	42.1	33.4	37.8	32.5	33.9	30.1
Miscellaneous private	36.7	35.2	38.9	37.6	37.8	37.7	38.5	37.9	36.4	34.2

[1]Symbols for the species are given in table 1.
[2]Includes lands under long-term lease.

Table 4.—Average ranking of suitable habitat, by ownership class and species, South Carolina, 1978

Ownership class	Species[1]								
	PRWA	WOTH	PINW	REVI	PIWO	DOWO	BRNU	PROW	EABL
National Forest	2.4	1.8	2.3	2.0	1.7	1.7	1.9	2.4	1.6
Other public	1.9	1.7	2.3	2.0	1.6	1.6	1.9	2.2	1.6
Forest industry[2]	2.4	1.7	2.2	2.3	2.0	1.8	1.8	2.6	1.8
Farmer	2.0	1.8	2.1	2.1	1.6	1.7	1.7	2.3	1.5
Miscellaneous private	2.1	1.8	2.2	2.2	1.8	1.7	1.8	2.5	1.5
Average, all owners	2.1	1.7	2.2	2.1	1.7	1.7	1.8	2.4	1.6

[1]Symbols for the species are given in table 1.
[2]Includes lands under long-term lease.

are not as pronounced for the quality of suitable habitat as those for the distribution because the magnitude of the suitable acreage is not a factor. There are differences, however significant, for some of the species.

Since the rankings in table 4 did not account for the acreage of suitable habitat for each species, another ranking was calculated to depict the overall suitability for each species on lands controlled by each ownership group (table 5). This ranking was calculated by summing all numerical ranking codes, by species and ownership, and dividing by the total number of plots on forest lands held by each owner group. This species ranking code may range from 0.0 to 3.0. An overall ownership ranking is shown in the first column.

National Forests have the highest overall ranking, resulting from higher than average species rankings for the pine warbler, pileated woodpecker, downy woodpecker, and brown-headed nuthatch. The other ownership rankings cluster around the overall average. By individual species, however, several differences become apparent. Forest lands controlled by other public agencies have higher than average species rankings for the pine warbler and brown-headed nuthatch and lower than average for the red-eyed vireo. Forest lands owned or leased by forest industries are better than average for the prairie warbler and the eastern bluebird. Few significant departures from the species averages are indicated for farmers and miscellaneous private landowners. Red-eyed vireo habitat is slightly better than average on forest lands owned by farmers.

Table 5.—Average nongame bird habitat suitability ranking, by ownership class and species, South Carolina, 1978

Ownership class	Owner ranking[1]	Species[2]								
		PRWA	WOTH	PINW	REVI	PIWO	DOWO	BRNU	PROW	EABL
National Forest	6.5	0.4	0.9	1.4	0.8	0.8	1.1	0.9	0.2	0.1
Other public	5.3	.5	.7	1.2	.6	.4	.8	.8	.2	.2
Forest industry[3]	5.6	.8	.7	.9	.8	.5	.8	.5	.4	.3
Farmer	5.4	.5	.9	.8	1.1	.4	.9	.5	.2	.2
Miscellaneous private	5.7	.5	.9	.9	1.0	.5	.9	.5	.3	.2
Average, all owners	5.6	.5	.8	.9	.9	.5	.9	.5	.3	.2

[1]Individual species' rankings may not add to the owner ranking because of rounding.
[2]Symbols for the species are given in table 1.
[3]Includes lands under long-term lease.

DISCUSSION

This study demonstrates that the habitat data and some basic techniques needed to evaluate large forested areas, in terms of their suitability for nongame bird breeding habitat (and the habitat of other nongame and game species), are now available. The results of the evaluations for the nine species seem reasonable, based on the general habitat and population descriptions found in the literature and used to formulate criteria. Research results are needed to replace the subjective criteria used in this evaluation. Field validation efforts are also needed to relate species occurrence and abundance to the projected rankings for each species. Once these two steps are accomplished, the evaluation process presented should prove to be a valuable tool.

The habitat evaluation techniques can be used to evaluate the habitat of a single species of interest or of entire avian communities. If quantified habitat guidelines for a large and diverse group of nongame birds can be assembled, then the forests in the Southeast can be evaluated for these avian communities by selecting several representative or indicator species to fit into each of the habitat groups. Several species are needed in each group to account for the variability among species occupying the same habitat. The results of the habitat evaluations for the nine nongame birds suggest that the species needed for evaluation are those most sensitive to habitat alteration and most restrictive in their selection of breeding habitat.

Estimates of the extent, distribution, and quality of nongame bird breeding habitat, such as that presented in this Paper, should make regional land management planning for nongame birds more feasible. A potentially more valuable asset of the system is that of monitoring the above habitat attributes over time. The RRE multiresource inventories are periodic, returning to each state in the Southeast about every 10 years. The trend information obtained from these reevaluations should prove to be essential input into the decisionmaking process for nongame bird management. The trends established can be related to changes in species composition, age structure, distribution, or management of the forest lands. Armed with this information, managers and policymakers can take steps to alleviate problems, prevent them from developing, and to better coordinate traditional forest management with nongame bird management.

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